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INFLUENCE OF COMMERCIAL AND INDIGENOUS STARTER CULTURES ON THE PHYSICO-CHEMICAL, MICROBIOLOGICAL AND SENSORY CHARACTERISTICS OF GOAT CHEESE

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Abstract: *Goat milk cheeses have gained considerable popularity within the European Union due to increasing consumer interest in both traditional cheese-making practices and the sensory and nutritional attributes associated with goat milk. Over the past two decades, demand for goat milk cheeses, particularly fresh varieties, has steadily increased among consumers seeking healthy and dietetic food products. These lactic-type cheeses are typically produced through acid coagulation, achieved by the addition of indigenous or selected lactic acid micro-flora in combination with a small amount of rennet. Considering the nutritional, functional, and commercial importance of goat milk cheeses, the primary objective of the present study was to develop a goat cheese variety using different starter cultures, including probiotic cultures, in order to identify the most suitable starter culture for the production of goat cheese characterized by a compact texture and a distinctive milky flavor. Furthermore, the sensory, chemical, and microbiological characteristics of the newly developed cheese were evaluated. The study also aimed to determine the product's storage stability and establish its shelf life while maintaining the desired quality and food safety parameters.*

• Introduction

In the production of different types of cheese, depending on the taste, aroma, and texture of the cheese, different types of microorganisms are used. For example, cheeses whose curd is cooked during the manufacturing stage are made using thermophilic starters such as Streptococcus salivaris subsp. thermophilus, Lactobacillus delbrueckii subsp. helveticus, and Lactobacillus delbrueckii subsp. lactis. On the other hand, for cheeses that require aging, mesophilic starters like Lactococcus species, Leuconostoc cremoris, and Lactobacillus casei are used. In aged cheeses, using a combination of lactococcus, streptococcus, and lactobacillus allows for faster acid production, protein breakdown in milk, and the synthesis of aromatic components due to the symbiotic relationship between them.

• Material and method

The raw material used to obtain the cheese samples was goat's milk, purchased from a local producer of traditional cheeses in Bihor County. The milk was stored under refrigeration until use. For each experimental variant, 7 liters of milk were used. Four cheese variants were obtained. The control variant was produced using a commercial starter culture (Lyofast CMS, composed of Lactococcus lactis subsp. lactis and Lactococcus lactis subsp. cremoris, 1.4 × 10^{10} CFU/mL). The three experimental variants were inoculated with the following bacterial cultures: (i) Lactococcus lactis subsp. lactis; (ii) a mix of Streptococcus salivarius subsp. thermophilus and Lactococcus lactis subsp. diacetylactis (1:1); and (iii) a consortium made up of Lactococcus lactis subsp. cremoris, Lactobacillus delbrueckii subs, bulgaricus , and Lactobacillus brevis. Starter cultures were added at a rate of 3% (v/v) relative to the volume of milk. After 30 minutes of incubation, rennet was added at a rate of 0.05% (v/v) and calcium chloride ($CaCl_2$) at a rate of 0.1% (w/v) to coagulate the milk and achieve a firm curd structure. The coagulation lasted for 90 minutes, after which the curd was cut into cubes about 1.5 cm on each side. The curd was pressed under a 3 kg weight for 2 hours to help remove the whey. Afterwards, the cheese samples were packed in polypropylene bags, vacuum-sealed, and labeled (Figure bellow.). The products were stored at temperatures between 4 and 9°C and left to mature for at least 7 days. At the end of the maturation period, the samples were subjected to physicochemical, microbiological, and sensory analyses.



• Results and discussions

The physico-chemical analysis of the four cheese samples, evaluated at 2, 5, and 7 days of ripening, highlights clear differences between the starter cultures used, as well as specific changes over the course of ripening. The values were statistically interpreted using the 5% LSD method, and indices (a, b, c) were attached to each value to indicate significant differences (Table 1).

Table 1. The effect of the starter culture on the composition of goat cheese

Sample/ Period	Average of the measurements							
	TS (%)	Fat (%)	Protein (%)	FS/TS (%)	Ash (%)	Salt (%)	Acidity (%)	pH
Control								
2 nd day	39.06^{a}	22.80^{a}	14.78^{ab}	58.37^{ab}	5.88^{b}	4.68^{b}	0.60^{a}	5.21^{a}
5 th day	41.05^{a}	22.65^{ab}	14.07^{ab}	55.17^{ab}	7.31^{b}	9.82^{a}	0.39^{a}	4.98^{a}
7 th day	41.60^{a}	22.80^{a}	14.50^{ab}	54.80^{ab}	10.00^{ab}	7.95^{ab}	0.36^{a}	4.57^{a}
Treatament 1								
2 nd day	37.70^{a}	22.50^{a}	13.70^{b}	59.68^{ab}	10.71^{ab}	5.85^{ab}	0.36^{ab}	5.01^{ab}
5 th day	39.12^{a}	23.25^{a}	14.63^{a}	59.43^{a}	13.63^{ab}	4.68^{b}	0.18^{ab}	4.68^{b}
7 th day	40.73^{a}	22.75^{a}	14.66^{a}	55.85^{ab}	6.45^{c}	7.72^{b}	0.18^{ab}	4.57^{a}
Treatament 3								
2 nd day	33.30^{b}	19.00^{b}	13.81^{b}	57.05^{b}	10.00^{ab}	8.19^{a}	0.18^{b}	4.86^{b}
5 th day	34.78^{b}	18.87^{b}	13.51^{b}	54.25^{b}	16.27^{ab}	5.61^{b}	0.18^{b}	4.80^{ab}
7 th day	35.81^{b}	19.25^{b}	13.73^{b}	53.75^{b}	10.34^{a}	7.72^{b}	0.18^{b}	4.62^{a}
Treatament 4								
2 nd day	34.69^{b}	21.00^{ab}	14.35^{a}	60.53^{a}	13.72^{a}	6.08^{ab}	0.18^{b}	4.89^{ab}
5 th day	33.28^{b}	19.50^{ab}	13.72^{ab}	58.59^{ab}	16.66^{a}	5.61^{b}	0.15^{b}	4.76^{ab}
7 th day	34.80^{b}	19.80^{ab}	13.95^{ab}	56.89^{a}	8.33^{b}	9.82^{a}	0.12^{b}	4.60^{a}

The total number of aerobic bacteria (TAB), Lactobacilli, Lactococci, and fungal microflora (molds and yeasts) gives a complete view of how the microflora develops during maturation (Table 2).

The sensory evaluation of the four matured cheese samples highlighted clear differences between the starter cultures used, confirming the previously presented physicochemical and microstructural observations. The panel of evaluators analyzed color, texture, taste and aroma, the presence of any off-flavors, perceived salt content, and overall acceptability. The results are summarized in Table 3. and interpreted below.

Table 2. The effect of the starter culture on the microbiological attributes of goat cheese

Parameter (UFC/g)	Sample 1	Sample 2	Sample 3	Sample 4
TAB	8.1x 10^{7}	6.3 x 10^{7}	9.3 x 10^{6}	2.1 x 10^{6}
Lactobacili	9.9 x 10^{7}	1.1 x 10^{7}	9.0 x 10^{6}	2.1 x 10^{7}
Streptococi	4.2 x 10^{7}	7.2 x 10^{6}	9.0 x 10^{6}	1.8 x 10^{6}
Fungal microflora	5.4 x 10^{4}	1.8 x 10^{4}	5.0 x 10^{4}	1.6 x 10^{4}

Table 3. The effect of the starter culture on the sensory attributes of goat cheese

Parameter	Sample 1	Sample 2	Sample 3	Sample 4
Color	7	7	7	8
Texture	5	9	6	9
Taste and Aroma	7	8	6	8
Nonspecific taste and aroma	9 (no)	9 (no)	9 (no)	9 (no)
Salt content	5 (salty)	6 (little salty)	4 (salty)	4 (saly)
Acceptability	6	8	6	8

Conclusions

These results demonstrate that mixed starter cultures, particularly those containing thermophilic lactic acid bacteria and aroma-producing strains, can improve the sensory quality of ripened goat cheese while maintaining appropriate physico-chemical and microbiological characteristics.